NOTARTHRINUS BINGHAMI, sp. n.

Agrees with de Nicéville's description of *Bothria chennellii*, except that it is without the discal line on the upper side of the fore wing, and the 6th spot of the row on the under side is all but obsolete. A more important difference is that in this row of spots, the first one in *chennellii* is in line with the others, in *binghami* it is markedly moved inwards, as in *argiolus* and many other Cyanirids.

I cannot help a suspicion that de Nicéville had these two species, *chennellii* and *binghami*, mixed (Col. Bingham, also, had not separated them), and when referring *chennellii* to *Cyaniris* had *binghami* in view.

Type in Col. Bingham's collection. A cotype in somewhat finer condition is in the museum at Tring. Col. Bingham's specimen is from Shillong; the Tring specimen is labelled "Khasia Hills, Assam."

EXPLANATION OF PLATE XXXVIII.

Fig. 1. Ancillary appendages of *Bothria chennellii* × 45.

Fig. 2. Ancillary appendages of *Notarthrinus binghami* × 45. The Ædœagus was unfortunately mounted on the slide too far off to come into the photograph. I have not based any characters of genus or species on it.

Both photographs by Mr. F. N. Clark.

5. A Contribution to the Knowledge of the Batrachian *Rhinoderma darwini*. By FRANK E. BEDDARD, M.A., F.R.S., F.Z.S.

[Received May 26, 1908.]

(Text-figures 143–149.)

I have examined a number of examples of this small Chilian Engystomatid Frog which were presented to the Society by Dr. E. P. Reid some months since. This examination enables me to add something to what is already known concerning this Batrachian, the breeding-habits of which are so remarkable and now so well known through the investigations of Gay, Espada, Howes and others, especially and most recently Prof. Bürger, for the loan of whose memoir written in Spanish I am indebted to Dr. Reid. Dr. Bürger * and Prof. Howes † give lists of the memoirs relating to this species, which I need not therefore recapitulate here. The contributions made respectively by the two authorities mentioned deal with the gular sacs, their structure and development. Incidentally some information is given in these papers concerning the visceral and muscular anatomy with which I have occupied myself for some time past; and so far as the facts go I am able to confirm those authors. As, however,

* La Neomelía de la *Rhinoderma darwini* D. & B., por el Dr. Otto Bürger. Santiago de Chile, 23 pp., 3 pls.

† "Notes on the Gular Brood-pouch of *Rhinoderma darwini*," P. Z. S. 1888, p. 231.

their object was not to enter into the general anatomy of *Rhinoderma*, but only to describe structures associated with the breeding-pouches, there is naturally some room left for a fuller account of this Engystomatid frog, which I specially compare with its African relative the genus *Breviceps*, dissected by myself some time since and referred to in a paper communicated to this Society lately *. *Rhinoderma* is an Engystomatid frog without a narrow mouth. The mouth is not far from being of the ordinary Batrachian capacity. The general aspect also of the species is widely removed from that of *Breviceps*, with which it would certainly not be associated were external characters alone taken into consideration. Externally, in fact, *Rhinoderma* is a typical frog, except indeed for the considerable projection of the upper beyond the lower jaw, and the presence of a narrow projection of the snout region of the head which has nothing to do with the nostrils. This process is not always present, but its presence or absence has nothing to do with sex, for I found the process well developed in one female, and absent in another female, both specimens being of about the same size. I have not, however, examined with care a sufficient number of examples to enable me to contribute any material facts with reference to the development of this "snout" †.

§ *Visceral Anatomy.*

The viscera show a number of differences from those of *Breviceps*.

The *liver* in *Rhinoderma* has not the peculiar form and relations to the heart which I have described in *Breviceps*. It is constituted more on the plan of that of *Rana*. That is, there is a primary division into right and left lobes of which the right is much the larger and is again divided into two lobes. The whole mass of the liver lies entirely behind the heart, which is not in the least hidden by it in the remarkable fashion which I have noticed in *Breviceps*. That this is the case is shown by the attachment to the posterior border of the pericardium of a peculiar muscle, which passes from the body-wall under the lobes of the liver without being attached to them and ends on the pericardium ‡.

The *alimentary tract* is proportionately and roughly of the same general appearance and length as that of *Rana*. There are, however, some differences, especially when the gut is slit up and the characters of the lining membrane in different regions compared with each other and with the corresponding or apparently corresponding sections of the gut of *Rana*. The stomach itself has a tendency to be more spherical in shape than in *Rana*. The part which ensues and corresponds in its position to the duodenum of

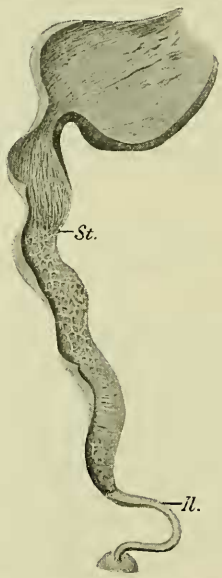
* P. Z. S. 1908, p. 11.

† The skull, showing the cartilaginous basis of this process, is figured by W. K. Parker (Phil. Trans. 1881, pl. 39, figs. i–iv).

‡ This is described below (on p. 684).

Rana demands attention before its homologies can be thus rapidly disposed of. Where this tube arises from the undoubted stomach there is no valve or change of a sudden character in its lining membrane. Furthermore, the pancreas does not extend down into the V-shaped loop which it makes with the stomach, and the ducts of liver and pancreas open into the alimentary tract farther up this ascending limb of the gastric U than they are represented to open in *Rana**. I am disposed in fact to assign the greater part of this ascending limb—the first deflection from an antero-posterior course which the whole alimentary tract shows—to the stomach. Its lining membrane has quite the characters of that of the lining membrane of the latter half of the undoubted stomach.

Text-fig. 143.



Alimentary tract of *Rhinoderma darwini* partly opened to show folds of lining membrane.

St. Posterior boundary of stomach. *Il.* Ileum.

It is very thick and arranged in close longitudinal folds which undergo no change where the tube suddenly lessens in calibre. Later on, a tendency to a reticulate arrangement also observable anteriorly becomes rather more marked. This thick layer suddenly ends near the top of the ascending limb of the V already referred to as characteristic of this and (? all) other frogs. Thereafter the walls of the gut are thin for a considerable distance and the lumen is perhaps slightly wider. The inner surface is very definitely reticulate in a honeycomb fashion. The break between

* Haslam's Translation of Ecker's 'Frog,' p. 296, fig. 195, Dc^2.

this section of the gut and that which precedes is rather in the abrupt thinning of the lining membrane than in anything else. Later on the reticulate arrangement is still retained; but there is a tendency towards emphasising the transversely running folds of the reticulum, but to nothing like the extent that is figured in *Rana**. These facts are well shown in the accompanying figure (text-fig. 143). The small intestine opens very abruptly into the short dilated colo-rectum. A little way in front of the junction of the two the ileum, as we may term it, becomes somewhat narrower in calibre and it has been for some distance thicker-walled. The end of the small intestine in fact is as thick-walled as that part of the tube (whatever its homologies may be) which immediately succeeds the dilated stomachal chamber. Both these regions contrast very markedly with the thin-walled middle section of the gut. On cutting open, these differences were very apparent. The colo-rectum is also thin-walled—at any rate in comparison with its calibre. The end of the ileum actually projects into it for some distance, like the uterus into the vagina. The figure which I give here of the intestinal tract of *Rhinoderma* (text-fig. 143) may be compared with that of *Breviceps* †, although the former is represented as seen when cut open and the latter is not. I have pointed out in *Breviceps* ‡ that the stomach does not end where it suddenly diminishes in calibre, but that it is clearly continued for a short distance along the upward limb of the U which it forms with the duodenum. I believe that in *Rhinoderma* this extension of the stomach is still greater.

Text-fig. 144.

Alimentary tract of *Rhinoderma darwini*, to illustrate the shortness of that of the male (upper figure) and the greater length of that of the female (lower figure).

The accompanying drawings (text-fig. 144) show the different appearance of the gut in the male and in the female of this frog.

* Haslam, *loc. cit.* p. 288, fig. 189.
† P. Z. S. 1908, p. 32, text-fig. 10.
‡ *Loc. cit.* p. 31, text-fig. 9.

When the body of the male is cut open, the whole of the alimentary tract is displayed and may be seen without moving that tract or adjacent organs. On the other hand, in the female the coils of the gut are rather more complex. The difference, as will be seen, is due to the greater accentuation in the female of the loops of the intestine. This is obviously associated with a considerable difference in the length of the tube in the two sexes. The measurements of two individuals were as follows:—In a male measuring 22 mm. from snout to anus (the anterior process of the snout being omitted) the gut from the commencement of the ascending limb, which may or may not belong really to the stomach, to the point of entrance into the colon of the ileum was only 18 mm. In a female measuring 28 mm. the gut was 35 mm. In the former, therefore, the gut is actually shorter than the body length. It is rather longer in the female.

§ *Uro-Genital Organs.*

The *kidneys* have the flattened leaf-like form that characterises those organs in *Rana*. They were, however,—in an example in which I measured them—proportionately very much larger than in an example of *Rana esculenta*, of which I made measurements for the purposes of comparison. The specimen of *Rhinoderma darwini* measured from the extremity of the snout (this example had not the anterior prolongation so characteristic of the species) to the anus 33 mm. The left kidney measured 8·5 mm., being thus very nearly one quarter of the length of the body—an extraordinary size. In correlation with this great size was the fact that the anterior extremity of the kidney nearly reached the anterior wall of the pleuro-peritoneal cavity, and the fat-bodies were so thrust against that anterior wall by the growth of the kidney that they lay back over it, being directed towards the vent. In a *Rana esculenta* measuring between the same points 175 mm., the length of the corresponding kidney was only 14 or 15 mm. Thus in this Batrachian (possessing a kidney of the usual size—in Ecker's 'Frog' 16 mm. is the length given) the kidney was only one-eleventh to one-twelfth of the body length. The difference is enormous.

The *testes* are spherical, much pigmented, and have the mulberry-like form of those of *Rana*. The fat-bodies in the one male which I dissected were much smaller than in both of two females which I also dissected. And moreover, in all three cases the left fat-body was larger than the right. In view of the peculiarity of the testes in *Breviceps* in possessing only one vas efferens, I was surprised to find that *Rhinoderma* is more normal in that each testis has four or five slender vasa efferentia.

The *oviducts* are long and thick and much coiled, and thus differ from those of *Breviceps*, presuming that the latter were fully advanced in development in the specimen which I dissected. It is remarkable that the proximal part of the oviduct (*i. e.* that

section immediately following upon the funnel) in *Rhinoderma* is very short and quite straight, much shorter than is, according to my experience, the rule among frogs. The funnel itself is attached sideways to the surface of the obliquus internus, where that muscle forms the anterior wall of the abdominal cavity, and is of an elongate form, the orifice being a comparatively narrow and terminal slit. The lining membrane is grooved at the mouth of the funnel. The oviducts open into the cloaca by a single common orifice.

§ *The Musculature of the Ventral Surface.*

The *rectus abdominis* shows no great peculiarities of structure. It has five divisions, visible when the skin is removed and no further dissection made. These are divided by four inscriptiones tendineæ. This contrasts in the most marked way with *Breviceps*, where there is but a single inscriptio tendinea. These are all behind the sternum, where the muscle appears to end. The anterior abdominal vein is visible from the last inscriptio tendinea up to just behind the sternum, where it dips down and disappears from view. The abdominal section of the *pectoralis* muscle arises from the first three poststernal masses of the rectus. The sternal portion of the pectoralis is hardly distinguishable from a *sterno-radialis* anteriorly; but the latter—if it exists as a separate muscle—is quite plainly divided off from the adjacent slender head of the deltoid. The posterior part of the *pectoralis sternalis* is distinct from the anterior region in that it comes closer to its fellow of the opposite side in the middle line than does the anterior part of the same muscle.

The *obliqui externus* et *internus* have not the extraordinarily complicated and specialised disposition of their bundles that I have described in *Breviceps verrucosus* *. The *obliquus externus* is a tolerably stout muscle the fibres of which run at right angles to the long axis of the body in the ordinary way, and which forms as usual a continuous sheet covering the sides of the body. Opposite to the second inscriptio tendinea of the rectus abdominis it is overlapped by the pectoralis abdominalis, and in this region arises (or is inserted) from that muscle, or rather from the septum between the two. In front of this area of overlap the obliquus externus is seen—when the here superjacent pectoralis abdominis is dissected away—to end abruptly at the septum between itself and the several compartments of the rectus abdominis. The fibres of the two muscles where they thus nearly come into contact are absolutely at right angles. Anteriorly and much at the same point, or rather along the same line, as in the Common Frog the obliquus externus ends definitely in a straight anterior border. There is not, however, in *Rhinoderma darwini* any trace that I could discover of an *omo-abdominalis* muscle, such as is

* P. Z. S. 1908, p. 22.

well developed and quite obvious in *Rana* and very greatly developed in *Breviceps*. It is rather remarkable that *Rhinoderma* not only shows no likeness to its ally *Breviceps*, but is even more simple than *Rana*. For some distance in front of the end of the obliquus externus the *obliquus internus* becomes obvious, its fibres running at an angle with those of the externus. These fibres end at the edge of the sternohyoideus just as the fibres of the obliquus externus end at the edge of the same muscle and of the rectus abdominis further back. This ending, however, is apparent rather than real. When the rectus is cut across, the obliquus externus is seen really to end abruptly at its outer boundary. On the other hand, the obliquus internus anteriorly dips into the body and forms a portion of the anterior partition between the neck and the trunk in a way which will be described immediately in connection with the *transversus* portion of the obliquus internus complex which was originally compared by Huxley to the Mammalian diaphragm, and which I have named accordingly in the following paragraph.

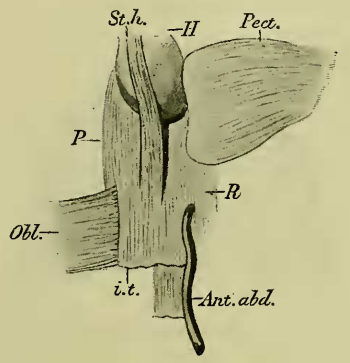
The *diaphragmatic muscle*.—This muscular sheet arises as is usual among the normal Batrachia Salientia—that is, the muscle has not the large extent and backwardly prolonged origin that it has among the Pelobatidæ *. It overlaps the kidney on its way to be inserted on to the œsophagus, which shows the enormous extension of that viscus forwards, upon which I comment elsewhere in this paper †. The muscle is entirely inserted on to the œsophagus from the point where the latter enters the pleuroperitoneal cavity up to nearly its junction with the stomach. The muscle also shares in the formation of the anterior wall of the pleuroperitoneal cavity; for it merges completely into the obliquus internus, the two meeting (though the exact line of junction cannot in the least be distinguished) at about the centre of the concave wall which they together form and which bounds the pleuroperitoneal cavity anteriorly, as has been said. It is difficult to say for this reason whether the muscle does or does not supply fibres to the root of the lung. In any case strands of the obliquus internus end upon the root of the lung.

Pericardial Muscle.—In the Common Frog a portion of the obliquus internus has been described as having the following relations to the pericardium and in the following words ‡:—"A third portion [of the muscle in question], placed behind the preceding, runs from the pharynx over the pericardium and is attached to this nearly as far as the middle line, resting on the sternum, the *m. rectus* and *m. sternohyoideus*. The lines of insertion of the muscles of opposite sides form an angle open in front." This is illustrated by a figure; but neither the figure nor the description appears to me to be clear. The portion of the obliquus internus thus referred to is perfectly continuous with the rest of

* Beddard, P. Z. S. 1907, p. 346, text-fig. 98; and p. 886.
† *Suprà*, p. 682.
‡ Ecker's Frog, Engl. Transl. p. 71.

the muscle (I distinguish the œsophageal muscle as distinct) which forms the internal sheet of the abdominal musculature. The region, however, now under consideration is that portion of the obliquus externus which is uncovered anteriorly by the obliquus externus. The latter muscle ceases at about the level of the apex of the heart, its most anterior region being separated off as the omo-abdominal muscle. In front of this the lateral wall of the pleuroperitoneal cavity is formed by the obliquus internus only, and this muscle (of course with its lining peritoneum) limits the abdominal cavity antero-laterally and constitutes the muscular wall of the "cervical limiting membrane of abdominal cavity" (Keith *). Ventrally this section of the internal oblique muscle becomes divided into two insertions. The most posterior ends in a delicate aponeurosis which passes outside of the sternohyoid muscle and is attached to the coracoid and sternum. The anterior

Text-fig. 145.



A portion of the musculature of the ventral surface of *Rhinoderma darwini*.

Ant.abd. Anterior abdominal vein. *H.* Heart. *i.t.* Tendinous intersection of rectus abdominis. *Obl.* Obliquus externus. *P.* Pericardial muscle. *Pect.* Pectoralis. *R.* Rectus abdominis. *St.h.* Sterno-hyoid.

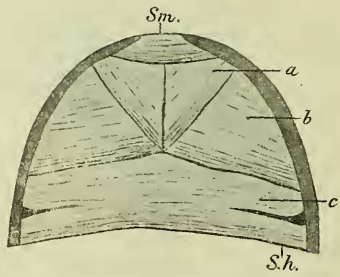
section of the muscle is attached by aponeurosis to the pericardium quite anteriorly (in the region of the emergence of the conus arteriosus), and to the roots of the lungs. The whole of the ventricular region of the pericardium is quite free from any muscular insertions. This fact (the freedom of the whole ventricular region of the pericardium from connection with the obliquus internus) is not plainly shown in the figure of Gaupp reproduced by Keith †. In addition to the insertion of obliquus internus fibres upon the anterior and lateral regions of the pericardium, Dr. Keith has remarked that some of "the deep fibres [of the rectus abdominis, behind the sternohyoid] may end on the

* J. Anat. Phys. xxxix. 1905, p. 244, fig. 1, explan. of figure.
† *Loc. cit.* p. 259, fig. 14.

pericardium." These will then form the ventral part of the diaphragm. I do not find after a careful dissection of an average-sized example of *Rana esculenta* any evidence of a deflection of rectus fibres to the pericardium. I am the more confident in the accuracy of my observation in that I have discovered such a muscle in the small *Rhinoderma darwini*. This I figure in the accompanying illustration (text-fig. 145). The muscle is thin and wide and flat, and its fibres run accurately in a direction parallel with the long axis of the body. It is attached to a good deal of the posterior and lateral margins of the pericardium. It underlies the obliquus externus behind the sternal region (*i. e.* is dorsal to it), and is therefore perhaps to be regarded as a portion of the obliquus internus.

The relations of the *submaxillaris* are different to those which obtain in some other frogs. The muscle is, however, similar in that its posterior region is separated off as a distinct muscle, the

Text-fig. 146.



Musculature of floor of mouth of *Rhinoderma darwini*.

a. Genioglossus (?). *b*, *c*. Differentiated portions of submaxillaris. *Sh*. Subhyoideus. *Sm*. Submentalis.

subhyoideus. The latter is only plainly differentiated from the former near to the edge of the lower jaw, where it dips down to a lower plane. Its relative dimensions appear to be very much those of the muscle in *Rana*. Nor is there anything in the structure or size of the *submentalis* that calls for particular comment. The muscle appears to be exactly like that of *Rana*. It will be noticed, however, in the accompanying drawing (text-fig. 146, *a*) that two large triangular muscles, one on each side, underlie the submaxillaris, which muscles are not visible in a corresponding dissection of *Rana*. Nor have I seen them in the same place in such Pelobatidæ as I have dissected *. These two muscles, as will be seen in the text-figure referred to, are closely approximated in the middle line; and into the space left by their divergence in front fits exactly the submentalis.

* On *Megalophrys nasuta*, P. Z. S. 1907, p. 338, &c., and on Pelobatidæ, *ib. t. c* p. 871.

These two muscles appear to me to be quite possibly the *genioglossi*, which are thus in the species *Rhinoderma darwini* not only of very large size but rather abnormal in position. They are normal only in that they arise on either side from the mandible; they are abnormal in that they have intruded into an area belonging to the submaxillaris which ceases to exist as a separate layer at the margin of the genioglossi. Furthermore, the intrusion of the genioglossi on to the superficial area of the throat has caused another peculiarity in the arrangement of the fibres of the submaxillaris. It will be seen from an inspection of text-fig. 146 that the fibres of the submaxillaris run in different directions in different portions of this muscle. Laterally to the possible genioglossi the fibres of the submaxillaris run obliquely to each ramus of the lower jaw; posteriorly to them the fibres are at right angles to the longitudinal axis of the head and run therefore accurately across the throat, with no obliquity of direction like the anterior part of the muscles. If I am right in identifying the triangular pair of muscles just described with the genioglossi of other Batrachians, they certainly differ in not being inserted on to the tongue (which of course does not necessarily do away with this suggested homology), for they can be easily dissected away with the submaxillaris, displaying the hyoglossus and geniohyoidei beneath. In any case, whatever be the nature of these muscles, it is clear that the muscular floor of the mouth in *Rhinoderma darwini* is peculiar and unlike that of other frogs. I should mention, furthermore, that there is no vestige in this frog of the small muscles at the side of the mouth lettered "*x*" in my figure of the muscular system of the ventral surface of the body in *Breviceps verrucosus* *. It may be that these muscles are the homologues of the peculiar muscles which I describe in *Rhinoderma* (text-fig. 146, *a*). If so, they have undergone in the one or in the other genus a very considerable shifting of position. It must be borne in mind that the species the anatomy of which forms the subject of my present communication to the Society is hardly to be described as "engystomatous."

§ *The Musculature of the Back.*

The *latissimus dorsi* (text-fig. 147, *L.d.*) is distinctly different from that of *Rana*, as figured. It is a distinctly narrow muscle, being about one half of the diameter of the underlying infraspinatus. Its course is straight and is exactly at right angles to the long axis of the body. It has no obliquity of direction as in other frogs. It is therefore also exactly parallel to the partly underlying infraspinatus. It arises from the middle line of the back behind the scapula. It did not appear to me to arise from the dorsal fascia; but as this pigmented membrane was so delicate it had to be picked away in little bits, and its relations were therefore rather

* P. Z. S. 1908, p. 16, text-fig. 3.

obscure. Still it seemed to be free of the underlying musculature including the longissimus dorsi except just at the spinous processes of the vertebræ.

The *rhomboideus* (or *retrahens scapulæ*) differs, as I have pointed out, in *Rana guppyi* * and *R. esculenta*; for in the former species it arises from the spine of a vertebra and is thus a true rhomboideus and not a serratus.

So also is this muscle in *Rhinoderma darwini*. It arises in front of the latissimus dorsi and is partly overlapped by it. It is at first rather broad, but narrows rapidly when it passes under the cucullaris into a narrower but still flat and strap-shaped muscle to be attached to the scapula.

The *depressor mandibulæ* is partly absent in this frog. There is no trace that I could discover of the dorsal part arising near to the latissimus dorsi. Nor do I think it possible to have missed this part of the muscle which is so obvious in those frogs where I have looked for it. It is important to notice that in this particular *Rhinoderma* agrees with its ally *Breviceps*. The other portion of this muscle, however, that arising from the skull-wall, is very large and passes as usual behind the tympanum, its antithesis, the *temporalis*, passing in front of the tympanum. Both these muscles are large and about equally developed.

The *infraspinatus* appears to cover the dorsal surface of the scapula nearly entirely from the extreme edge of its ventral margin. Only a thin edge of the scapula (indicated by dots in text-fig. 147) is left exposed, not so much as in *Breviceps*.

The *cucullaris*, or *levator scapulæ*, is a large and well-developed muscle as is shown in the figure (text-fig. 147). Its direction is oblique, the obliquity being towards the dorsal median line postero-anteriorly. In this region it covers a part of the anterior section of the longissimus dorsi, that inserted on to the head.

The *longissimus dorsi* is quite like that of *Rana*, and is shown together with the adjacent muscles in the accompanying text-figure (text-fig. 147). They all agree on the whole with those of *Rana*, and a reference to my figure will show this agreement in detail. The *ilio-lumbaris* is rather more marked on the dorsal surface. The view of this muscle from the inside of the body is rather different from that of *Rana* †. It runs uninterruptedly over the transverse processes of four vertebræ (beginning with the sacral ‡), and was finally inserted on to the one in front, *i. e.* the fifth reckoning from behind forwards. This is also the fifth vertebra of the series commencing with the atlas. From this vertebra to the fourth a band of muscles runs in the same straight line as the ilio-lumbaris, but not in continuity with its fibres. This transverse process (that of the fourth vertebra) gives origin

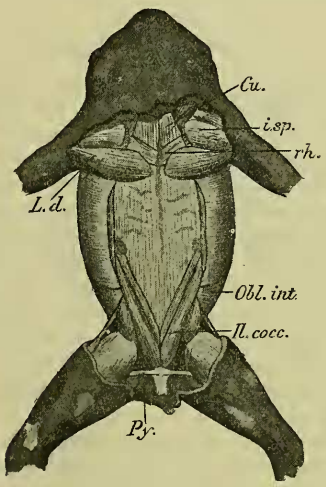
* Anatomy of *Pipa*, P. Z. S. 1895, p. 835. I am able to confirm this statement after a re-examination of that frog.

† Beddard, P. Z. S. 1907, p. 333, text-fig. 94 (*Rana guppyi*).

‡ I may note that this vertebra was not fused with the coccyx.

to the *transverso-scapularis* muscle *, which is best seen on the view presented by the dissection now being described, and which is therefore dealt with here and not in its proper place. The ilio-lumbaris gives off slips to the transverse processes lying between its origin from the ilium and its insertion on to the fifth vertebra; but these are concealed from view when the body-cavity is opened and the muscle exposed, for a considerable mass of its fibres runs directly and without interruption between the extremes of origin and insertion. It suggests, therefore, the long slip of the

Text-fig. 147.



Dorsal musculature of *Rhinoderma darwini*.

Cu. Cucullaris. *i.sp.* Infra-spinatus. *Il.cocc.* Ilio-coccygeus. *L.d.* Latissimus dorsi. *Obl.int.* Fan-shaped tract of obliquus internus attached to ilium. *Py.* Pyriformis. *rh.* Rhomboideus.

ilio-lumbaris in *Megalophrys nasuta* †, which appears, however, in that frog, and in the Pelobatidæ generally ‡, to be more completely differentiated from the rest of the ilio-lumbaris than is the case with *Rhinoderma darwini*. More noteworthy is the exact likeness which this muscle shows to the corresponding muscle in *Breviceps*.

The *coccygeo-sacralis* and *ilio-coccygeus* are present and obvious as is shown in the figure (text-fig. 147), but have no special features of interest. On this view the *glutæus*, the *rectus femoris*

* It is noteworthy that only one pair of these muscles appears to exist in *Rhinoderma*; for there are two in *Rana*. The above dissection also showed plainly the *Levator anguli scapulæ* arising from the skull quite as in *Rana*.

† P. Z. S. 1907, p. 332, text-fig. 93, *Il. lumb.*

‡ P. Z. S. 1907, p. 871.

anticus, and the *pyriformis* are exposed and very prominent. It will be seen from the drawing (text-fig. 147) that there is no possible room for an enormous lymph-heart like that which I have described and figured in *Breviceps* on either side of the spine. Nothing of the kind can, I believe, have been overlooked by me. A peculiarity of the obliquus internus is shown on the view of the dorsal musculature which is illustrated in text-fig. 147, *obl.int.* A fan-shaped origin of this muscle from the ilium is to be seen underlying the obliquus externus. The origin is by a head of very limited extent from the ilium just above the origin of the glutæus muscle, that is, about halfway down the bone. An iliac origin of this muscle is of course known in *Rana*.

§ *Musculature of Hyoid.*

I have dealt at some length in my paper upon the anatomy of *Breviceps* with the hyoid musculature of that frog. This musculature presents, it will be recollected, more than one peculiar feature. The corresponding musculature of *Rhinoderma* does not present many peculiar features, and agrees on the whole with that of *Rana*, differing therefore from its near ally *Breviceps*, to which however it presents some likeness, as I have identified, and have no particular comments to make upon, the following muscles, which appear to me to be like those of *Rana*, viz., *geniohyoideus* and *omohyoideus*. The *sternohyoideus*, on the other hand, appears to me to be like that of *Breviceps* in that it consists of two portions with a quite separate insertion on to the hyoid. The larger and more superficial half of the muscle has not the same origins as the sternohyoid of *Rana*, for there is no sternum to arise from, and it is simply a continuation of the rectus and completely conceals (when the animal is viewed from the ventral surface in the usual position of dissection) the underlying portion of the muscle. This is very slender, and is connected only in its origin with the abdominal musculature. It is inserted on to the hyoid a considerable distance behind the insertion of the larger half of the muscle, and the insertions are not continuous. Just below this muscle lies the pericardial muscle which I describe on another page (see p. 684). It is interesting to note that the sternohyoid is completely free from the shoulder-girdle, and is merely a continuation of the rectus abdominis.

The *petrohyoidei* are as in most other frogs; *i. e.*, there is an anterior and a posterior petrohyoideus and the latter is divided into three slips. The latter muscle is entirely inserted upon the bony thyrohyals, and the three slips of which it is composed form a continuous mass of muscles which are broad and leave no interspaces. The last of the series, as in some other frogs, lies rather superficially to the rest and is attached to the tip of the thyrohyal bone ventrally. It also seems to pass beyond it as in *Xenophrys* *, and to be therefore associated with the vocal apparatus.

* See Beddard, P. Z. S. 1907, p. 898, text-fig. 238, *p.h.* 3.

§ *Muscles of the Thigh.*

When the skin is removed and the muscles of the thigh inspected from the inner aspect (text-fig. 148), some difference is visible from the appearances observable in *Rana* under similar conditions. For figures of *Rana* I may refer to Ecker's 'Anatomy of the Frog,' and to a figure of the muscles of the inside of the thigh in the large *Rana guppyi* *, illustrating a paper by myself on the structure of the Pelobatidæ. I have also figured the corresponding muscles of *Breviceps* †, an African genus belonging to the same family (Engystomatidæ) as that which contains the subject of the present communication to the Society. Although there are

Text-fig. 148.

Thigh-muscles of *Rhinoderma darwini* exposed from the inside.

R. Rectus abdominis. *v.i.m.* Rectus internus minor, where it is attached to the skin. *V.i.* Vastus internus. *Sa.* Sartorius.

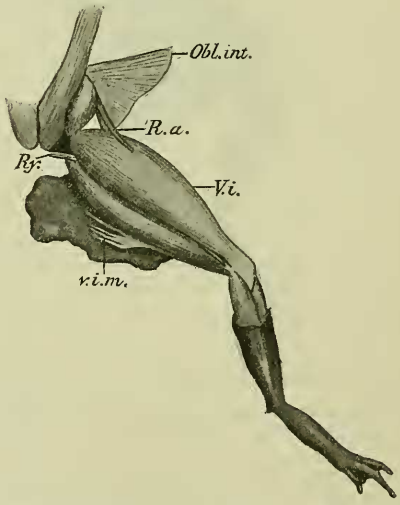
differences in detail between the thigh muscles of *Rhinoderma* and those of *Rana*, the general aspect of the muscles—with one important exception, to be mentioned presently—is much like that of *Rana*, and is even definitely more like *Rana esculenta* than *R. guppyi*. It is easy to recognise the *vastus internus*, *adductor longus*, *sartorius*, *adductor magnus*, *adductor brevis*, *rectus internus major* and *rectus internus minor*, lying in the order named (and commencing of course at the anterior border of the thigh) and having roughly much the same proportions as the corresponding muscles of *Rana esculenta*. Moreover, it will be noticed that the smallest adductor muscle lies after the adductor magnus as in *Rana esculenta*, and not in front of it as in *Rana guppyi*. There is, however, visible, as is well shown in the above figure (text-fig. 148), an important

* P. Z. S. 1907, p. 887, text-fig. 234. † P. Z. S. 1908, p. 25, text-fig. 6.

difference between *Rana* and *Rhinoderma*, which is at the same time a point of agreement between *Rhinoderma* and *Breviceps*. The *rectus internus minor* arises in *Rhinoderma* by a number of more or less separate origins from the skin of the thigh, which origins are very far from reaching the middle line of the abdomen. The muscular strands which combine to form this muscle are spread out upon the skin, when the latter is cut through and reflected, in a divergent fashion. There are four or five of these strands, which are naturally flat bands. In *Breviceps* such an extra-skeletal origin of skeletal muscles in the femoral region is more largely developed than in *Rhinoderma*; but, as will be seen by a reference to my paper already quoted, the rectus internus is similarly involved in this system of skin muscles.

Viewing the thigh muscles from the dorsal aspect (see text-fig. 149) and their origins (in some cases) from the back, one

Text-fig. 149.



Thigh-muscles of *Rhinoderma darwini* exposed from the outside.

Obl.int. Fan-shaped portion of obliquus internus attached to ilium. *Ry.* Pyriformis. *R.a.* Rectus anticus. *v.i.m.* Rectus internus minor. *V.i.* Vastus internus, lying to the outside of the vastus externus.

obvious and striking difference from *Breviceps* is to be seen. The coccyx runs very nearly to the extremity of the body; there is not the lengthy exposure of the cloaca with certain muscles attached thereto and accompanying it that I have figured in *Breviceps* *. To the tip of the coccyx is attached the *pyriformis*, which in the usual way reaches the femur by passing between the *vastus externus* and the *semimembranosus*. The disproportion

* P. Z. S. 1908, p. 35, text-fig. 11.

between the two last-named muscles is greater than it is represented to be in *Rana*. The figure of *Rhinoderma* (text-fig. 149) shows that in that frog the vastus is more than twice the breadth of the semimembranous. The *rectus anticus* of *Rhinoderma* is peculiar in that it is a very small and slender muscle covered at its origin from the ilium by just the front end of the glutæus. It is thus an inappreciable portion of the *triceps femoris* complex. The *biceps femoris* is much hidden by the vastus externus and semimembranosus, between which it lies. Indeed it is only visible for a very short distance at its insertion. In this the genus agrees with *Breviceps*.

The *semitendinosus* is not shown in the two figures (text-figs. 148, 149), which illustrate the musculature of the thigh, since it is completely hidden on the inner aspect of the thigh by the rectus internus major. When the latter is cut through and reflected the semitendinosus is brought into view. It is formed by the union of two heads as in *Rana*; but these do not unite until more than halfway down the thigh. They are moreover fleshy throughout and roughly speaking of equal size. One head arises, as the thigh is seen dissected from the ventral aspect, superficially to the other. It arises from the symphysis pubis in close apposition to the great adductor and the two recti abdominis. The second head is better shown when the first head is cut through and reflected, since it is distinctly deep of it. It is then seen to run back to its origin in close apposition to the rectus internus major and to arise from the pubis very close to it. I observed no tendinous origin of this head, and no such connection with its head as is figured and described in the Common Frog.

§ *Resumé of facts and Systematic Position of* Rhinoderma.

As might be expected from their very different way of life, the genus *Rhinoderma* presents, as we have seen, numerous anatomical differences from its ally *Breviceps*. Several of these are already known, and are described in such works as Mr. Boulenger's 'Catalogue of the Batrachia Salientia,' and in Dr. Gadow's treatise on Amphibia and Reptiles in the 'Cambridge Natural History.' I leave aside in the present enumeration those external and osteological features which are dealt with in those and other works. A general survey of the structure of the muscles shows plainly that *Breviceps* has departed much further from the more usual structure of the Batrachia Salientia than has *Rhinoderma*. And this statement applies also to the viscera. The extraordinarily enlarged posterior lymph-hearts of *Breviceps* are not found in *Rhinoderma*; the liver of the latter has the more normal form of that of *Rana*. It is, however, in the musculature that the most numerous divergences between the two types are to be met with. The remarkable specialisation of the obliquus muscles, which I have described in detail in *Breviceps*, does not occur at all in *Rhinoderma*, which is broadly speaking like *Rana* in this respect.

Partly in consequence of this the hyoid musculature of *Rhinoderma* is closely like that of *Rana*, the omohyoid being present, which muscle has disappeared in *Breviceps*. On the other hand, the musculature of the floor of the mouth is quite specialised in *Rhinoderma*, and different from that of any other frog the anatomy of which has been described.

On the other hand, there are a few points in which *Rhinoderma* does resemble *Breviceps* and departs so far from the structure of *Rana*. The sternohyoid seems to be a double muscle in both, though the duplicity of the muscle is not so strongly marked in *Rhinoderma*. The attachment and general appearance of the iliolumbaris of *Rhinoderma* is distinctly like that of *Breviceps*. In both, the rectus internus minor of the thigh arises partly from the skin, and in neither frog is there the dorsal part of the depressor mandibulæ muscle present. In my paper upon *Breviceps* I have selected 17 characters of importance to distinguish that frog from *Rana*. It is only in four of these characters that *Rhinoderma* agrees with *Breviceps* to differ from *Rana*.

Nor are there any special points of likeness between the two genera here considered in any other features not mentioned in the list of the seventeen principal characters referred to, except, of course, such general features as both *Rhinoderma* and *Breviceps* share with *Rana*.

The divergences are most remarkable; and yet there are at least two equally remarkable points of resemblance, *i. e.* the origin of the rectus internus femoris and the absence of the dorsal part of the depressor mandibulæ. There can be no doubt, however, that, whatever may be the value of these points of resemblance, the two genera are quite as far removed from each other within the limits of family relationship as diversity of geographical position would lead us to expect. A wider knowledge of this order of animals may reveal surer bases for anatomical criteria.

6. Some Notes upon the Anatomy of *Chiromys madagascariensis*, with references to other Lemurs. By Frank E. Beddard, M.A., F.R.S., F.Z.S.

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(Text-figures 150–153.)

The opportunity of examining three specimens of the Aye-Aye (*Chiromys madagascariensis*) has enabled me to add a few new facts to what is already known concerning the structure of this remarkable Lemur. The three principal Memoirs dealing with the structure of *Chiromys* are (in order of appearance) those of Owen*, Peters†, and Oudemans‡. These authors have dealt with the preceding literature relating to the animal. The

* Trans. Zool. Soc. vol. v. † Abhandl. k. Akad. Wiss. Berlin, 1865.
‡ Verh. Akad. Amst. 1890. See also Chapman, P. Ac. Philad. 1900, p. 419.